DEUTONYMPHS AS ENDOPARASITES OF THE EASTERN BELTED KINGFISHER AND THE EASTERN GREEN HERON IN NORTH AMERICA (ACARINA: SARCOPTIFORMES: PTEROLICHIDAE)[1]

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Heteromorphic feather mite deutonymphs of two different species of mites were recovered: the one from the Eastern belted kingfisher, *Megaceryle alcyon*, and the other from the Eastern green heron, *Butorides v. virescens* in North America. There have been few reports of heteromorphic deutonymphs, which inhabit the subcutaneous tissue of birds, in the New World. According to Spurlock and Emlen ('42), the mite which they described as *Hypodectes chapini* n. sp. from the red-shafted flicker, *Colaptes cafer collaris*, in California, constitutes the second species specifically identified in North American birds. The first species is *Falculifer rostratus* Buchh. (Falculiferinae) from the pigeon: its deutonymph was first observed in the United States and on the pigeon by Garman (1884), and since by Kellicott (1892) and Beebe (1902). A subdermal deutonymph was reported but not illustrated from the little blue heron by Leidy (1890), and by Beebe ('02), who also collected it from the white ibis and the roseate spoonbill. Since these hosts belong to the order Ciconiiformes, this mite probably represents a third species and it may very likely be identical to that now described by the author from the green heron.

The deutonymphs of the subfamily Pterolichinae which have been illustrated from Old World hosts are *Ardeacarus ardeae* Can. from herons (Dubinin, '56); *Coraciacarus alcedinia* Filippi from the kingfisher, *Alcedo atthis*; *Gabucinia strigia* Gene from the short-eared owl, *Asio flammeus*; *G. nisi* Can. from the sparrow hawk and goshawk (*Accipiter nisus*, and *A. gentilis*) and *G. vulturis* from the griffon vulture, *Gyps fulvus* (Dubinin, '53). To this list should now be added three unnamed deutonymphs, two from the Indian white-headed ibis, *Tantalus leucocephalus* and one from a touraco, *Tauraco porphyreolophus* (Grünberg and Kutzer, '62a, '62b). In the past, various generic names have been assigned to some of these deutonymphs, such as *Cellularia* Montague, *Hypodectes* Fillipi, and *Hypoderas* Nitzsch (Grünberg and Kutzer, '62a).

Of 50 belted kingfishers examined for parasites, 22 were infested by heteromorphic deutonymphs (one host from Ontario, Canada, 21 from

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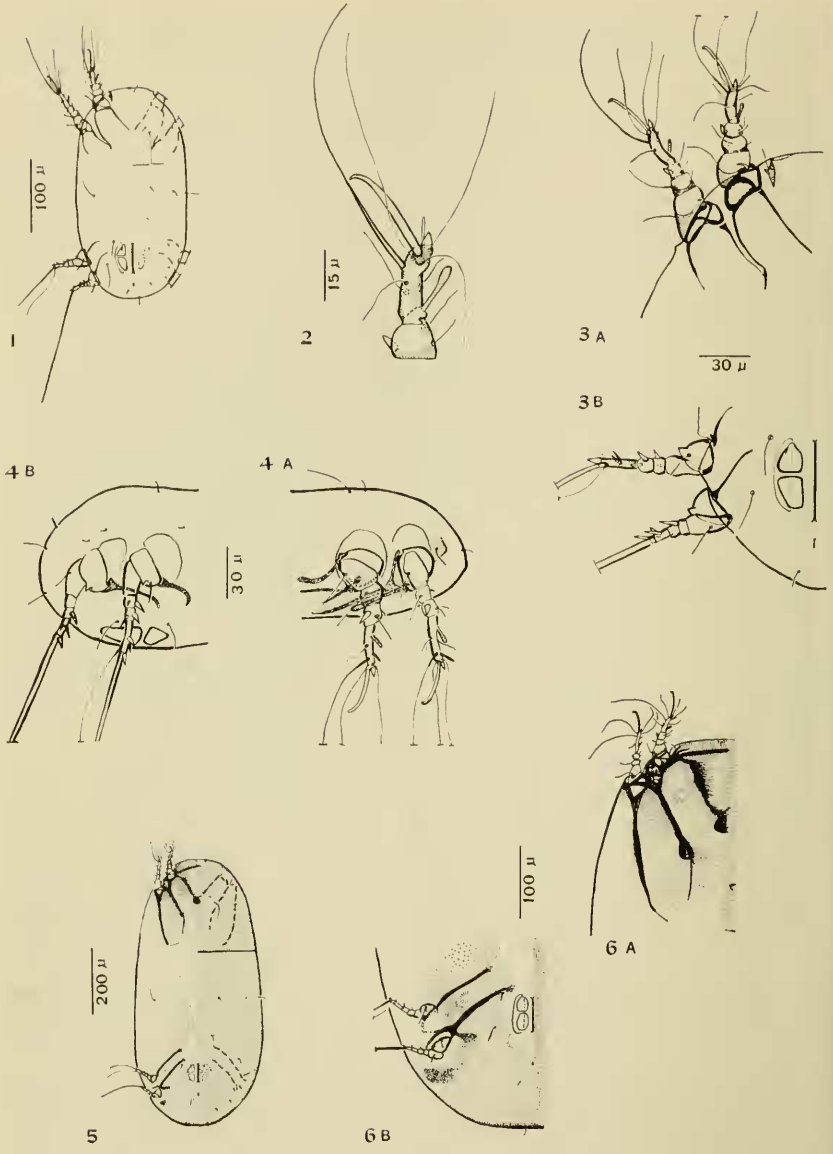


Figs. 1–6. Heteromorphic deutonymph, *Gabucinia alcyon*, n. sp. Figs. 1–4 First stage deutonymph. Fig. 1, Ventrodorsal view, fig. 2, Tarsus and segment 5 of leg 1; fig. 3A, Anterior portion of right side, ventral view; fig. 3B, Posterior portion of right side, ventral view; fig. 4A, Anterior portion body, side view; fig. 4B, Posterior portion body, side view. Figs. 5, 6, Third, mature, stage of deutonymph. Fig. 5, Ventrodorsal view; fig. 6A, Anterior portion right side, ventral view, same magnification as fig. 1; fig. 6B, Posterior portion—same as 6A.

Massachusetts, U.S.A.). They represent three distinct stages of maturity and were obtained in two ways: by detergent washings of the skin and of the carcass, and by examination of the inner surface of the upper eyelid. Using the detergent technique, 6 of the 22 hosts were found to harbor first stage, and the remaining 16 third stage (mature) deutonymphs. The eyes of 5 of the birds in the latter group were examined and all three stages of deutonymph development were present. The deutonymph of the green heron was obtained in one out of 23 birds from Massachusetts. Only three specimens, mature forms, were collected; they were found in the adipose tissue of the axilla and the groin.

Gabucinia alcyon, n. sp.

(Figs. 1–6)

Stage 1: (Figs. 1–4). Body transparent, cylindrical to oval, 280 μ by 130 μ (range 240–336 μ by 112–160 μ); depth 100 μ; ratio width to length 1 : 2.09.

Dorsum (Fig. 1). Setae 13 pairs—one mid-terminal anteriorly, 15 μ long; two pairs level coxae I (inner minute; outer 50 μ); four pairs between coxae II, III (three in a straight line, the outermost the longest, 23 μ); 6 pairs in genito-anal level (one median, four postero-lateral, one terminal). Sclerotized areas lacking. Dorsal septum beginning to form in approximately half the specimens as a small median demarcation, 15 μ long, just posterior to level of coxae II.

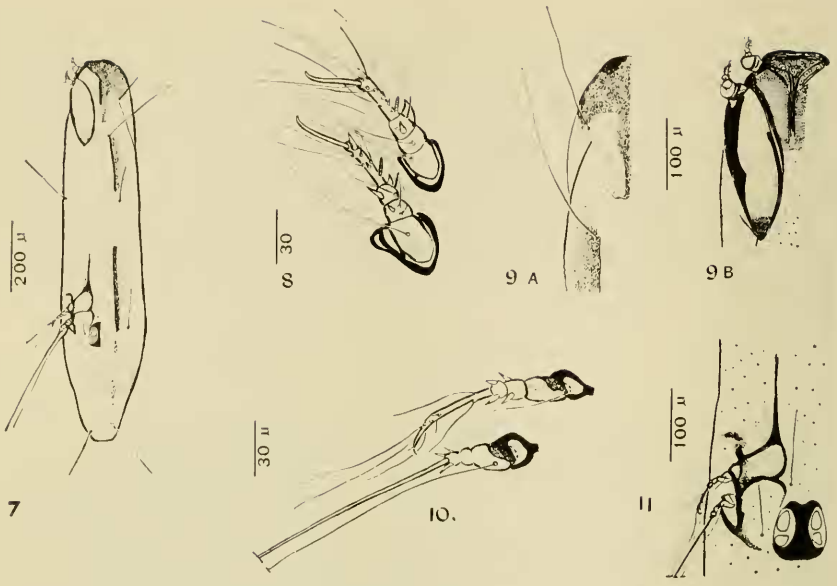
Venter (Figs. 1, 3, 4). Setae 5 pairs—one palpal, 23 μ, in a groove; one lateral, halfway between coxae II and III, 38 μ; two genital 22 μ and 37 μ long; one posterior, 8 μ. Palpal rudiment visible. Genital region consists of a central bar and two pairs of plates. The bar is 46 μ long, slightly bifid at each end; anterior and posterior plates measure 16 by 16 μ and 18 by 15 μ. The two plates of each side are bordered laterally by a crescentic chitinous bar. Anus, a longitudinal slit, 10 μ from genital region and 22 μ from posterior end body.

Leg I (Figs. 2, 3A, 4A): 60 μ, strongly chitinized. Anterior epimeron free, posterior epimeron fuses with anterior epimeron of leg II; coxa open, 46 μ. Segment two, one minute claw-like seta on ventral border; segment three, one seta postero-ventral; segment four, one anterior bristle and one dorsal seta; segment five, two anterior setae (one dorsal, one ventral) and one postero-dorsal spine. *Tarsus* (Fig. 2): one proximal anterior sensory seta, 10 μ, slightly swollen distally, three short setae, and distally, one dorsal anterior bristle, one posterior long seta with thick base, 90 μ in length; 5 terminal processes—anterior spine, two setae at its base, one posterior claw, 30 μ, and one seta at its base.

Leg II (Figs. 3A, 4A): Similar to leg I except tarsus, which has a tapering sensory seta, bristle short, and only one seta, not two, at the base of the terminal spine, otherwise like tarsus I.

Leg III (Figs. 1, 3B, 4B): 60 μ; epimeron curves anteriorly, free; coxa open. Segment two, one anterior spine and one ventral seta; segment three lacks setae; segment four, one anterior and one dorsal spine; segment five, one anterior and one dorsal spine. *Tarsus*, two spines along its stem (one anterior, one dorsal); one terminal spine with a tiny seta at its base, one long posterior seta, 77 μ, and a more delicate, dorsal seta.

Leg IV (Figs. 1, 3B, 4B): Epimeron short projecting anteriorly, parallel with



Figs. 7–11, Heteromorphic deutonymph of *Ardeacarus americanus*, n. sp. Fig. 7, Ventrodorsal view; fig. 8, Legs I and II, segment three to tarsus; fig. 9A, Anterior portion left side, dorsal view; fig. 9B, Anterior portion right side, ventral view; fig. 10, Legs III and IV, omitting coxae; fig. 11, Posterior coxae and genital region, right side, ventral view.

that of leg III. Segment two, one anterior spine; segment three, one ventral seta; segment four, no setae; segment five, one anterior, and one dorsal spine. *Tarsus* terminates in one anterior spine and one long seta, 173 μ, and along its stem two spines (one anterior and one dorsal).

Stage 2: Length 590 μ, width 240 μ, depth 208 μ (range 448–616 μ length; 260–300 μ width). Distance between anterior end and leg II increased only from 73 μ to 108 μ; whereas distance between legs II and III increased from 184 μ to 540 μ, thus greatest growth is in the middle and posterior regions of body—distance between posterior boundary of genital region and posterior end body has increased from 88 μ to 199 μ. Dorsal septum present and varies in length from 201 μ to 243 μ (i.e. almost complete). Sclerotization of the body has begun especially dorsally and along anterior end of body. The anterior edge is heavily sclerotized and a supporting bar is growing in from the sides, thin at first and incomplete. Epimera I approach the mid-line; sternum is developing independently; all three are approaching each other. All epimera are thickening and elongating. Epimera I and II fused together; those of leg II are approaching each other indicating closure of coxae II. Epimeral lengths of legs I to IV in some specimens reach lengths of 96, 127, 173, 96 and 108 μ respectively.

Stage 3 (Figs. 5, 6): 800 μ by 300 μ with a depth of 224 μ (range 720–816 μ by 272–400 μ). Dorsal septum complete. Sclerotization complete on dorsum, heavy along anterior edge, light just posterior to dorsal septum. Ventrally, the anterior

region between epimera I is heavily sclerotized, especially the anterior rim, which is supported by a bar. Other sclerotized areas include coxae I, II and III and all the region from coxae IV and genital plates to posterior end; a slight sclerotized flange runs forward from coxa III of each side for half the body length; a sclerotized patch runs back of leg IV; two clear areas, one on coxa I and the other on coxa III, are visible and are probably precursors of setae. Distance between legs II and III range from 502 to 596 μ. Epimera I are fused to sternum and are 115 μ in length. Epimera of leg II are 127 and 293 μ long and approximate each other; epimera of legs III and IV are now 100–119 μ.

The holotype is a mature specimen and has been deposited in the U.S. National Museum as No. 3165 along with paratypes representing all three stages in deutonymph development.

Ardeacarus americanus, n. sp.

(Figs. 7–11)

Body cylindrical, opaque yellowish-white. 1.12 mm by 0.24 mm; ratio width to length 1:4.7.

Dorsum (Figs. 7, 9A): Setae 6 pairs relatively short—two in anterior quarter (the inner more posterior and longer), one medio-lateral in anterior two thirds of body; one medio-lateral at level of genital plates; two postero-median. Five sclerotized regions; the first, 134 μ long, extending from anterior end to coxae I; two pairs medio-lateral longitudinal strips in anterior and posterior halves of body.

Venter (Figs. 7, 9B, 11): Setae four pairs—one lateral in middle third of body; two pairs of small genital and one posterior pair. Genital region heavily sclerotized, 270 μ from posterior end, measures 84 by 77 μ and encloses two plates on each side. Anus not visible.

Leg I (Fig. 8): 80 μ long, heavily sclerotized proximal segments. Epimeron I fused with sclerotized anterior region so that coxa I is 110 μ long; posterior epimeron fuse with epimeron of leg II. Segments three and four each with one seta. Segment 5 with one bristle and a large spine on anterior edge, a dorsal (outer) spine and one seta.

Tarsus elongate ending in a claw and a spine; processes from proximal to distal end consist of one anteriorly directed sensory, one small spine, 6 setae and one bristle at the base of the terminal spine.

Leg II (Fig. 8): 80 μ long. Coxa sclerotized and complete, 110 μ by 75 μ, posterior end 270 μ from anterior end. Segment three with one seta; segment four two setae (one dorsal, one ventral) and a dorsal spine. Segment 5, one anterior spine and bristle, one dorsal spine and seta. *Tarsus* terminates in a claw and a spine; along its stem occur one sensory seta, one small spine and four setae. Distance between emergence of legs II and III 640 μ.

Leg III (Fig. 10): 100 μ long. Epimeron extends anteriorly for 120 μ; coxa closed, 45 μ by 41 μ. Segment two, one seta, segment three, one dorsal spine; segment four and 5, one anterior and one dorsal spine each. *Tarsus* long and narrow, 60 μ, terminating in a small spine-like claw, and bearing 6 setae and two small bristles.

Leg IV: 46 μ; coxa incomplete, 320 μ from posterior end. Segment three, one long seta, 330 μ; segment four, no setae; segment five, two anterior and one dorsal spine terminating in one long stout seta, 330 μ long.

The holotype has been deposited in the U.S. National Museum as No. 3166.

Remarks: The deutonymph from the green heron is a species of the genus *Ardeacarus* (tribe—Pterolichini), and is a close relative of *A. ardeae* (Dubinin, '56), which parasitizes herons in the Old World. This identification is based on two factors: the comparison of their deutonymphs, and the presence in the green heron of adult *Ardeacarus* sp. on the wing feathers.

Both deutonymphs possess four basic features in common: the legs, and the anterior coxae and sternal regions have the same pattern; the 5 dorsal plates are similarly arranged and the ratio of width to body length is 1 : 4. The major differences between the two lie in the number and position of the ventral setae and in the nature of the posterior coxae and genital area. In *A. ardeae,* there are two pairs of long lateral setae (not one) as well as the posterior pair and no genital setae; the anterior extension of coxa III is lacking; coxae IV unite medially enclosing the genital plates, and the median part of the genital region is not strongly sclerotized. A minor difference is the presence of three sclerotized spots for muscle attachment on the anterior coxa-sternal region. The dorsal setae of *A. ardeae* have not been illustrated, nor is there any detailed description of the legs. It is difficult in the diagrams of the legs to recognize the spines so characteristic of those legs of the green heron deutonymph.

Eight of the 23 green herons harbored *Ardeacarus* sp. on the feathers of the wing. All stages (eggs, nymphs and adults) were readily observed, and the host with the heaviest population of adults was also the one from which the deutonymphs were collected. *Ardeacarus* sp. has not been previously reported from *Butorides v. virescens.*

In comparison with the above pterolichin deutonymphs, the American kingfisher mite is not a member of this tribe but possibly of the Pseudalloptini, to which *Coraciacarus alcedinis* (host, Old World kingfisher) and species of *Gabucinia* (hosts, owls, hawks belong (Dubinin '53). All these deutonymphs possess three characteristics in common; ratio body width to length 1 : 2; 2 pairs dorsal setae at level of coxa I, of which the inner is minute, and a similar pattern to the anterior coxa-sternal region. The deutonymph of *C. alcedinis* differs from the American kingfisher mite in several respects. These include the venter setae (one on coxa I only one genital, and no lateral or posterior setae); closed coxa III and its configuration with the genital plates. The claw of tarsus I and tarsus II do not show in the diagram. The American kingfisher deutonymph may be a species of *Gabucinia,* for it shares many features in common with this species. All have coxae III and IV incomplete, distinctly separate from the genital area, which exhibits the same basic pattern throughout. It appears closest to

G. nisi from the sparrow hawk and goshawk since both possess two genital setae and a simple arrangement of the genital plates. However, the adult feather mites collected from the wing feathers, along with the egg and nymphal stages, have been identified by Dr. Atyeo as *Pterodectes* sp. (Proctophyllodidae). They occurred in 18 hosts, often in abundance. Of the 18 birds 11 also harbored these deutonymphs. Yet, heteromorphic feather mite deutonymphs are characteristic of the family Pterolichidae! It would be unusual to repeatedly find only deutonymphs of a species in a host and no adults, therefore it is likely that they actually represent the dormant stage of *Pterodectes* sp. and do not belong to the genus *Gabucinia* despite their morphological resemblance to its members. Feather mites have not been reported in the literature from the American Kingfisher.

The growth changes which the young deutonymph undergoes, once it settles in the adipose tissue following its migration and penetration, before reaching its dormant hypermorphic condition are described in detail for *Ardeacarus ardeae* (Can.) by Dubinin ('56). These changes, in the main, parallel those observed between stages I and III in the deutonymph of the Kingfisher mite. They are the result of endosmotic nutrition and include extensive body growths, especially the coxal fields and middle regions, although ratio of width to body length remains virtually the same; elaboration of the anterior coxa-sternal area and sclerotization of the body. The absolute size of the setae and of the legs (except for coxae) remains unchanged. Unlike *A. ardeae* the elaboration of the anterior coxa-sternal area is slight and the posterior coxae and genital regions undergo no further differentiation.

In stage II, epimera I approximate each other as the primordium of the sternum becomes visible, but their actual fusion does not occur until stage III. Sclerotization first appears at stage II. A fourth sign of differentiation is present in the deutonymph of the kingfisher mite, namely the establishment of a dorsal septum. This is barely perceptible, if at all, in specimens of stage I but is better defined at stage II and completed by stage III.

The deutonymph from the green heron has reached the dormant mature stage, for the size of the body is proportionately far greater than the dimensions of the setae and legs; the pattern of the anterior coxa-sternal and posterior coxa-genital regions is well advanced, as is the sclerotization of the body.

The structure of the legs of the deutonymphs is of interest, for each is strongly sclerotized and equipped with numerous spines which are either terminal or arise from the anterior or dorsal surfaces. The tarsus of each of the anterior legs in both species possesses a sensory seta and a terminal claw, and leg IV ends in a long stout stilt-like seta.

These processes undoubtedly play an important role in the migration of the deutonymph to its final destination in the host.

The distribution of heteromorphic deutonymphs has been illustrated for four hosts by Dubinin ('51). In the pigeon, they congregate in the connective tissue of the large blood vessels of the neck, occasionally also in the axilla. They aggregate in the subcutaneous adipose tissue of the heron in the region of the coracoid and the sternum (along its posterior border and on each side of the keel). A few may sometimes be found in the connective tissue of the neck blood vessels, the trachea, the lungs and between the muscle bundles of the neck and chest. This distribution holds true for those parasitizing the Old World kingfisher and the hawks; in the latter group of birds they also occur in the axilla. Grünberg and Kutzer ('62a) diagrammed the position of the deutonymphs in the white-headed ibis—the connective tissue of the axilla and groin, between the thigh muscles, and a few in the region of the cloaca and breast. In the green heron, the author collected them from the axilla and the groin. Spurlock and Emlen ('42) reported their presence in the red-shafted flicker in the connective tissue of the trachea, extending from the tongue to the lungs. The location of the deutonymphs of the kingfisher was only discovered through cutting the upper eyelid free from the rest of the skin and bringing it forward in order to examine its anterior inner surface. The deutonymphs, representing all three stages, occurred massed together in the connective tissue, where the nictitating membrane arises at the anterior end of the orbit. When the mites were observed in the one eyelid, the other also proved positive for them. It should be noted that in birds the lower eyelid is the mobile one; thus, the upper eyelid forms a relatively undisturbed, and thus favorable site for this dormant stage of the mite. They were never found on the nictitating membrane, in the orbit or on the inner surface of the body skin. In heavy infestations, they had often spread to the inner surface of the lower eyelid, along the jaws, tongue, esophagus and trachea.

Of the 6 hosts where only young deutonymphs were collected from detergent washings, the eyelids of 5 thoroughly examined and proved negative for mites. It is assumed that these stage I deutonymphs were in the process of migrating from the wing to their final destination in the connective tissue of the upper eyelid.

It has been postulated that the young deutonymph reaches its subdermal site either through the feather follicles or through the respiratory organs (Spurlock and Emlen, '42). Recently Grünberg and Kutzer ('62a) have offered evidence to the effect that the protonymph crawls out through the superior umbilicus, and molts into the deutonymph on the adjacent skin region. Then the young deutonymph migrates through the split, which arises between the feather sheath

and the skin prior to molting, into the hypodermis. In the American kingfisher, however, its deutonymph may reach its dormant site in the upper eyelid directly, irrespective of the plumage or respiratory organs and independent of the molting season.

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NEW COLEOPTERA RECORDS FROM NORTH CAROLINA

While collecting Coleoptera by means of a modified Berlese funnel, I found the following three species representing families or subfamilies not previously recorded from North Carolina. The determinations were verified respectively by Dr. H. S. Dybas of the Chicago Natural History Museum, Mr. H. R. Steeves, Jr. of Birmingham, Alabama, and Dr. John Kingsolver of the U. S. National Museum. The specimens are deposited in my own collection and that of the Entomology Department of N. C. State University, Raleigh, N. C.

Limulodidae: *Limulodes paradoxus* Matthews. Eight specimens from nest of a small yellow *Lasius* ant, probably *L. umbratus mixtus* Nyll. Raleigh, Wake County, N. C., 8 Sept. 1964. J. F. Cornell.

Pselaphidae (Clavigerinae): *Adranes coccus* LeConte. One male, 3 females from nest of a small yellow *Lasius* ant, probably *L. umbratus mixtus* Nyll. Raleigh, Wake County, N. C., 8 Sept. 1964, J. F. Cornell.

Sphindidae: *Sphindus americanus* LeConte. Fourteen specimens, from pine and oak logs with *Polyporus* fungi on the bark. 6 miles N. of Salemburg, on N. C. 242 Sampson County, N. C., 2 May 1964. J. F. Cornell and C. D. Mampe.—J. F. Cornell, *Dept. of Entomology, Oregon State University, Corvallis, Oregon 97331*